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(54) HOT RUNNER STRUCTURE FOR PLASTICS INJECTION MOLDS

(71) I, LADISLAO (WLADYSLAW) PUTKOWSKI, of Canadian nationality, of 21 Limarick Avenue, Weston, Ontaria, Canada, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a hot runner structure for plastics injection molds.

In the art of injection molding, molten plastics is usually supplied under high pressure by an injection molding machine to a mold structure, where it is received by a sprue bushing. From the sprue bushing, the plastics is commonly conducted by heated conduits, called hot runners, into various mold cavities (or to different parts of the same cavity). When the plastics finally enters the mold cavity it sets to form a desired part. To ensure rapid setting, the mold structure is usually water cooled in the vicinity of the cavity.

The molten plastics is usually conducted from the hot runner into the mold cavity through a small opening called a gate. Complex structures have been used in the past to conduct the plastics from the end of the hot runner to the gate, and these structures have been subject to the difficulty that the plastics has tended to set prematurely in the gate or between the end of the hot runner and the gate.

According to the present invention, there is provided, for a plastics injection mold structure including a cavity plate and a mold cavity bounded at least in part by the cavity plate, a hot runner structure comprising: a hot runner member having a first end for receiving plastics to be injection molded and a tubular second end for discharging the plastics; means for mounting the hot runner member for axial expansion and contraction movement of the second end relative to the cavity plate; a substantially cylindrical insert member sealingly fitted in the second end of the hot runner member and having an end portion projecting from the second end of the hot runner member; and a passage in the insert member for conducting the plastics from the hot runner member and for discharging the plastics from the insert member, the projecting end portion of the insert member having an end which in use co-operates with an opening in said cavity plate for directing plastics through the cavity plate into the mold cavity, the insert member being slidable within the second end of the hot runner member so that the insert member does not interfere with said axial movement of the second end of the hot runner member relative to the cavity plate.

Embodiments of a structure according to the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of a structure which is not in accordance with the present invention but which is included in order to illustrate the general construction of a mold structure in which the hot runner structure can be incorporated, showing a sprue bushing and hot runner in position on a cavity plate;

Figure 1A is a bottom plan view of an insert member of the structure of Figure 1;

Figure 2 is a view in section along line 2—2 of Figure 1 with a front plate removed and with a spacer plate shown only in dotted outline;

Figure 3 is a sectional view showing a portion of hot runner structure according to the invention, in position on a cavity plate arranged to operate as an externally operated valve;

Figure 4 is a perspective view of a piston of the structure of Figure 3;

Figure 5 is a view similar to Figure 3 showing a plastics pressure-operated valve;

Figure 5A is a plan view of a spring used in the valve of Figure 5;

Figures 6 and 7 are top plan views of the insert member shown in Figure 5;

Figure 8 is a bottom plan view of the insert member of Figure 5;

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Figure 9 is a sectional view of a further embodiment of the structure of the present invention;

Figure 10 is a sectional view showing the end of a hot runner tabular member slidably inserted in a bore and showing a seal;

Figure 11 is a sectional view of a heater;

Figure 12 is a perspective view of a portion of a ceramic core of the heater of Figure 11;

Figure 12a is a sectional view of a modified heater;

Figure 13 is a sectional view of a slidable gate insert member and associated structure;

Figure 14 is a sectional view of the insert member of Figure 13, with a torpedo in place therein; and

Figure 15 is a sectional view along lines 15—15 of Figure 14.

Reference is first made to Figures 1 and 2, and more particularly Figure 1, which illustrate the general construction of a mold structure in which a hot runner structure according to the invention can be included. The construction of Figures 1 to 3 is not according to the invention as claimed in the appended claims, in that the insert member is not slidable within the hot runner member, as will be described hereinafter. The mold structure shown comprises a mold cavity plate 2 forming with another plate 4 a cavity 6 into which molten plastics is to be injected to form a desired part. Cooling channels (not shown) are provided in the cavity plate 2 to permit flow of cooling water therethrough. Connected to the cavity plate 2 are three further plates, namely a rear plate 8, a spacer plate 10 (shown in dotted outline in Figure 2), and a front plate 12. The rear plate 8 and spacer plate 10 are fastened together and to the cavity plate 2 by screws (not shown), and the front plate 12 is fastened to the spacer plate 10 by screws 14.

The front plate 12 serves to clamp in position a sprue bushing generally indicated at 16. The sprue bushing 16 receives molten plastics from an injection molding machine (not shown) by way of a central axial channel 18, and then directs this plastics outwardly through a radial bore 20. A relieved portion 22 at the bottom of the sprue bushing 16 reduces heat transfer from the hot sprue bushing through rear plate 8 to the cool cavity plate 2.

From the sprue bushing 16, the molten plastics travels through a hot runner generally indicated at 24 and is then injected through a gate (i.e. an outlet aperture) 26 in the cavity plate 2 and then passes into the mold cavity 6.

The hot runner 24 comprises a tubular member 30 having a first end 32 sealingly but slidably fitted into the bore 20 in the sprue bushing, and a second end 34 snugly but slidably fitted into a bore 36 in the cavity plate 2. The end 34 of the tubular member 30 includes a sealing sleeve 37 (which will be described later in connection with Fig. 10) which forms a seal between the hot runner and the wall of the bore 36. (The seal between the first end 32 of the tubular member 30 and the sprue bushing bore 20 is formed simply by the snug fit between these parts.)

Because the axes of the bores 20, 36 are oriented in the same plane but at right angles to each other, the tubular member 30 has a right angle bend indicated at 38 in its centre, so that it is shaped generally in the form of a letter L.

Plastics flowing through the tubular member 30 is maintained at a desired temperature by a pair of heaters 40, 42 which encircle the tubular member 30 on each side of the bend 38. The heaters, 40, 42 are conveniently made by selecting a ceramic tube of a diameter to fit over the tubular member 30, winding a heater wire around the ceramic tube, placing the resulting combination in a metal sleeve, and injecting an appropriate bonding material or cement between the ceramic tube and metal sleeve. Between the heaters 40, 42 there is located a bushing 44 of insulating material such as ceramic.

The inner diameter of the outlet end of the tubular member 30 is enlarged as shown at 46 to accommodate a substantially cylindrical insert member which is press fitted into the end of the tubular member 30 before the tubular member 30 is slid into the bore in the cavity plate 2. The insert member 48 is locked in place in the tubular member 30 by a set screw 28 which extends through the wall of tubular member 30 and into a circumferential groove in the outer wall of the insert member 48.

The insert member 48 has an axial interior bore 49 and three spaced outlet passages 50. The passages 50 direct plastics into a chamber 50a defined by the wall of the bore 36, the end 34 of the hot tubular member 30, and the insert member 48. From the chamber 50a the plastics flows into the gate 26. A reduced diameter tip 51 of the insert member 48 penetrates into the gate 26 but is spaced from the walls of the gate 26 by a few thousandths of an inch, to allow plastics to pass through the gate into the mold cavity 6.

The arrangement shown, by which the molten plastics is directed through spaced passages in the insert member 48, into the top of the chamber 50a, keeps the plastics in the chamber 50a flowing and prevents the plastics from stagnation or setting. The insert member 48 is preferably made of a material which is a better heat conductor (e.g. berillium copper) than the material of the tubular member 30, to conduct heat to the plastics flowing through the gate 26 to prevent setting in the gate. The total sectional area of

passages 50 is approximately equal to that of bore 49.

The hot runner 24 further includes a short upper tube 52 welded to the bend 38 of the tubular member 30. The tube 52 contains a threaded bore 54 to receive a bolt 56 which holds the hot runner in position relative to the spacer plate 10.

It will be noted that the end 32 of the tubular member 30 is spaced from the inner end of the bore 20 in the sprue bushing 16. This allows the hot runner to expand in the direction of arrows A—A as the hot runner is heated, without tending to tilt the axis of the bore 36 or the insert member 48 relative to the plates 2, 4. The amount of room needed to allow for lengthwise expansion of the tubular member 30 in the direction of arrows A—A is fairly small. For example, if the member 30 is stainless steel and is four inches long in the direction of arrows A—A (this is a typical length), then it will expand approximately only twenty-thousandths of an inch during heating to operating temperature. However, if the expansion room described were not provided, then differential expansion between tubular member 30 and cavity plate 2, even though slight, could cause misalignment of the bore 36 and insert member 48 and would cause difficulty in molding. The spacing between the end of the tubular member 30 and the inner end of bore 20 is sufficient to allow for the maximum expected expansion of tubular member 30.

Tubular member 30 is preferably made of a material having a greater thermal coefficient of expansion than the material of the sprue bushing 16. For example, tubular member 30 can as indicated be made of stainless steel, while the sprue bushing can be made of tool steel. This permits easy assembly of the parts while they are cool, with a snug but slidable fit when they are hot.

Similar provision for expansion in the direction of arrows B—B is made at the other end 34 of the tubular member 30, because of the sliding fit between the end 34 and the cavity plate 2. However the firm fit of the insert member 48 with the member 30 would tend to interfere with this expansion and contraction movement of the member 30 relative to the cavity plate.

Although the sprue bushing 16 has been shown as having only one bore 20, it can be provided with a number of radial bores as indicated in dotted lines at 58, to feed other hot runners. The hot runners may be made in various lengths as required.

It will be noted that the hot runner 24 is largely separated from the rear plate 8 by air gaps 60, 62. In fact, the hot runner contacts the plates 8, 10 and the cold mold plates only at three points, i.e. at the sprue bushing, the tip of the upper tube 52, and at the seal between the end 34 and the cavity plate 2. This reduces heat transfer from the runner to rear plate 8 and hence to the cavity plate, and yet the hot runner is securely held in position.

Reference is next made to Figure 3 wherein primed reference numerals indicate parts corresponding to those of Figures 1 and 2. The Figure 3 embodiment differs from the Figures 1 and 2 embodiment in that the insert member 48′ is slidable relative to the runner member 30′ within which it is a sliding fit, and is powered externally, so that the gate 26′ can be opened and closed as desired. To this end, the bore 46′ in the tip of the tubular member 30′ is made of a diameter such that the insert member 48′ can slide snugly but smoothly therein, and the bore 46′ is made long enough so that there is a clearance 70 between the upper end of the insert member 48′ and the upper end of the bore 46′ when the insert member 48′ is in its lowermost position. When the insert member 48′ is in its lowermost position, it completely blocks and closes the gate 26′, and when the insert member 48′ is raised, plastics is permitted to flow through the gate. A typical stroke for the insert member 48′ is .020 inches.

The insert member 48′ is driven by a piston 72 (see Figure 4) snugly fitted within a co-operating cylinder 74 formed in the rear plate 8′. The piston 72 is inserted from the top of the rear plate and is held in position by an insert 76 The insert 76 is held against a shoulder 77 of the rear plate 8′ by the pressure of the spacer plate 10′. The piston 72 includes a central flange or ring 78, so that air may be introduced into the cylinder 74 below the flange 78 via an aperture 80 in the rear plate to drive the piston upwardly, or alternatively, air may be introduced into the cylinder 34 above the flange 78 via an aperture 82 to drive the piston downwardly.

The piston 72 is connected to the insert member 48′ by two pins 84 which extend through holes 85 in the tip of tubular member 30′ and are screwed into the piston 72. Plastics does not normally escape through the holes 85 because of the tight sliding fit between the insert member 48′ and the interior wall of the tip of the tubular member 30′. However, after the tight sliding fit between the insert member 48′ and the interior wall of the tip of the tubular member 30′ becomes loosened by wear, a small amount of plastics will escape through the holes 85. This plastics is directed to the outside of the mold through drain passages 86a in the rear plate 8′, leading to the bottom of the mold structure. The escaping plastics provides a visual indication that wear of the parts has occurred.

Reference is next made to Fig. 5, in which

double primed reference numerals indicate parts corresponding to those of Figs 1 and 2. The Fig. 5 embodiment is similar to that of Fig. 3 in that the insert member 48″ is movable, but the insert member 48″ is now fitted with an enlarged diameter collar 90 which slides snugly within an enlarged bore 92 in the end of the tubular member 30″. A flexible sleeve seal 94 (also to be described in connection with Fig. 10) seals the collar 90 against the walls of the bore 92 to prevent leakage. The lower end 105 of the collar forms part of the seal for the chamber 50a″.

Instead of being moved by a piston, the insert member 48″ is biased to a closed position by a pair of flat springs 96, also shown in Figure 5A. The springs 96 are inserted through a pair of opposed slots 98 on the walls of the tubular member 30″ and engage in a circumferential groove 100 in the collar 90 of the insert member 48″. The springs 96 are U-shaped in cross-section, with end tabs 102 and 102a which extend outwardly under the edges of the slots 98 to retain the springs 96 in position.

As shown, the tabs 102a nearest the chamber 50a″ press against the lower wall of the groove 100 to urge the insert member downwardly. The upper walls 104 of the springs press against the walls of the slots 98 in the tubular member 30″. The upper tabs 102 of the springs 96 are spaced from the upper wall of the groove 100 to permit downward movement of the insert member 48″. Venting slots 106 are provided to permit escape of air in the upper part of the bore 92 as the insert member moves up and down.

In operation, the springs 96 normally force the tip 51″ of the insert member 48″ into the gate 26″ to close the gate. Plastics, when injected, passes through the opening 50″ into the chamber 50a″, where the pressure tends to force the insert member 48″ upwardlv. The insert member 48″ will be forced upwardly when the pressure of the plastics becomes high enough, and will then permit plastics to pass through the gate 26″ into the mold cavity 6″. Thus the combination of the spring-loaded insert member 48″ and the gate 26″ act as a control valve to control the flow of plastics into the cavity 6″.

The pressure at which the insert member 48″ will move upwardly can be roughly calculated as follows. Assume that the cross-sectional area of the top of the insert member 48″ is X, as indicated bv the shaded area in Fig. 6, the cross-sectional area of the insert member 48″ at the bottom surface 105 of the collar 90 is Y, as indicated by the shaded area in Fig. 7, and the cross-sectional area of the normally closed extreme tip 108 of the insert member is Z, as indicated by the shaded area in Fig. 8.

Then, when the valve is closed, the plastics presses down on area X and up on area Y—Z (since tip Z lies against the gate 26″ and is not acted on by the plastics) and the plastics pressure required to open the valve is

$$\frac{\text{spring force 96}}{\text{area Y}-(\text{area X}+\text{area Z})}$$

Once the valve is open, the plastics presses down on area X and up on area Y and the pressure required to hold the valve open is

$$\frac{\text{spring force 96}}{\text{area Y}-\text{area X}}$$

By way of example, if the areas are Y=.1503 square inches, X=.0767 square inches, Z=.0048 square inches, and the force applied by the spring 96 is 30 pounds, then (a) valve opening pressure is 447 psi, (b) pressure to hold valve open is 410 psi, and (c) valve closing pressure is spring force ÷ area Z, which is 6000 psi, with no plastics pressure.

It will be noted that the springs 96 shown in the Fig. 5 embodiment, since they are located in an air space, are exposed to less heat than would be the case if a coil spring located between the insert member 48″ and the tubular member 30″ were used. It will be seen that the springs 96 not only provide spring action, but also they constitute retaining means to hold the insert member 48″ in position, and further they form a stop which prevents the heater 42″ from being moved too far downwardly.

It will be appreciated that the valves of Figures 3 and 5 can if desired be operated in injection molding machines to turn the the flow of plastics on and off after the plastics has been injected. For the spring-operated valve of Figure 5, the valve opening pressure can be controlled by varying the pressure of the springs 96 and by changing the relation of areas X and Y.

Although the hot runner 24 has been shown as comprising an L-shaped tubular member 30, it can instead (see Figure 9) be formed from a straight tubular section 110 extending in the direction of arrows A—A and fitted into a bore 112 in a nozzle 114. The tubular section 110 corresponds to and is similar to the horizontal leg of the L-shaped hot runner 24 of the Figures 1, 3 and 5 structures, and extends into the sprue bushing, preferably with a snug sliding fit. The tubular section 110 is also snugly but slidably fitted into the bore 112 in the nozzle 114.

The nozzle 114 is a generally cylindrical member encircled by a heater and having an axial passage 116 to direct plastics towards the mold cavity. Nozzle 114 corresponds to the vertical leg of the hot runner 24 of Figures 1, 3 and 5 and includes at its

tip an insert member (not shown) which is similar to the insert member 48 of Figure 1 and which protrudes through a chamber like the chamber 50a (of Figure 1) in the cavity plate and into a gate opening (not shown) in the cavity plate. The nozzle 114 is fitted into a bore 118 in the rear plate 8''' and a bore 120 in the spacer plate 10''' and is held in place by a screw 122 projecting through plate 10'''. If desired, additional bores 124 can be provided in the nozzle 114 to feed plastics to additional hot runners.

Although the hot runner tubular sections and the bores in which they are fitted have been shown as extending either parallel to or at right angles to the plates of the cavity plane 2 and rear and spacer plates 8, 10, they could be directed at any angle to these plates, so long as they are slidably connected at least at one end to allow for lengthwise expansion. The invention can be used for a small single cavity mold, in which case only one straight hot runner section will be provided (either simple or valved), corresponding to the vertical leg of hot runner 24 of Fig. 1 but with a straight-through bore.

Reference is next made to Fig. 10 which, as mentioned above, shows a seal for use on the end of a hot runner which is to be slidably fitted into a bore. Such a bore is shown at 130 in Fig. 10, the bore 130 typically being located in a sprue bushing such as that shown at 16 in Fig. 1, or in a cavity plate such as that shown at 2, 2' or 2'' in Figs. 1, 3 and 5 respectively.

The seal in Fig. 10 is formed by a generally cylindrical sleeve 132 overlying a reduced diameter end portion 134 of a hot runner tubular member 136 and projecting beyond the reduced diameter portion 134. The part 131 of the sleeve 132 which overlies the portion 134 of the hot runner tubular member 136 is of a diameter slightly less than that of the bore 130, leaving a clearance 138 between the two. The diameter of the part 131 could be equal to that of the bore 130. The projecting portion 140 of the sleeve 132 is of diameter the same as or very slightly larger than that of the bore 130 (e.g. .000 to .002 inches oversize when the parts are cold), to produce a snug but slidable fit. The sleeve 132 is of thin hardened flexible stainless steel so that the projecting portion 140 of the sleeve 132 can flex when inserted into a bore. The end of the bore which receives the sleeve 132 will be bevelled (although this is not illustratd) to facilitate insertion of the sleeve.

Since the material of the sleeve is normally different from that of the hot runner tubular member 136 (the hot runner tubular member 136 will normally be tool steel or conventional stainless steel), the sleeve 132 is normally joined to the hot runner tubular member 136 by silver soldering.

When plastics is injected through the apparatus shown in Fig. 10, the seal between the portion 140 of the sleeve 132 and the walls of the bore 130 is sufficient to prevent leakage and to allow the plastics pressure to increase. As the plastics pressure increases, it forces the walls of the projecting portion 140 against the walls of the bore 130 and improves the seal. If desired, the exterior surface of the sleeve portion 140 can include a circumferential groove 140a which traps plastics and helps to improve the seal.

An important advantage of the seal shown in Fig. 10 is that it provides a good seal, and yet the area of contact between the hot runner tubular member 136 and the wall of the bore 130 is relatively small, thus reducing heat transfer from the hot runner to the bore. Preferably the reduced diameter part 131 of the sleeve extends at least .040 to 0.60 inches beyond the end of the end portion 134, to reduce heat transfer. A further advantage is that if the sleeve 132 is damaged, it can be removed and a new sleeve applied to the hot runner tubular member 136.

Typical dimensions for the seal shown in Fig. 10 are as follows:

		Dimension (inches)
A	(length of sleeve portion 131 overlying hot runner	3/16
B	(length of sleeve portion 140)	1/8
C	(Thickness of sleeve portion 131 overlying hot runner)	.025
	Clearance 138	.025
D	(Thickness of sleeve portion 140)	0.50
E	(Diameter of bore 130)	1/2

Reference is next made to Fig. 11 which shows an alternative heater 141 for a hot runner. The heater 141 consists of a generally semi-cylindrical core 142 of low thermal conductivity (see also Fig. 12) having a number of longitudinal grooves 144 extending along its inner or concave surface. Adjacent pairs of grooves are joined at their ends by cross-grooves 146. An electrical resistance wire 148 is embedded in the grooves 144 and follows a serpentine path back and forth through the grooves, crossing between the grooves at the cross-grooves 146. The resistance wire 148 is held in place by high thermal conductivity ceramic cement 150 which also forms a layer approximately .050 inches thick above the tops of the grooves 144. The ends of the resistance wire 148 are connected to lead wires 152 which are brought out to a suitable power source. The core 142 and resistance wires 148 are enclosed in a metal external shell 154.

The inside surface 156 of the shell 154 is semi-circular in cross section, with a radius such that it fits snugly over a hot runner tubular member such as the tubular member 136 of Fig. 10. In order to provide approximately the same insulation around the entire circumference of the hot runner tubular member, another heater similar to heater 141 is used as a spare, but not connected. The two semi-cylindrical heaters are placed over the hot runner tubular member and clamped in place using any suitable conventional clamps, such as metal straps diagrammatically indicated at 158.

The spare heater used as insulation for the hot runner tubular member need not contain a heater wire 148.

Heaters such as that shown at 141 can be made very cheaply while maintaining high accuracy so that the heaters fit the hot runner tubular members closely, to ensure maximum heat transfer. In addition, since the heaters are semi-cylindrical, they can be applied to and removed from the hot runner tubular members (in order to exchange burned-out heaters) without disassembling the hot runner tubular members. In addition, if the spare heater contains an element, then its element can be connected after that of the operating heater has burned out, thus extending the time between replacement of heater parts.

Although the heaters have been shown as semi-cylindrical, they could extend around a lesser arc, e.g. 90 degrees, so that four heaters would be required instead of two to enclose a hot runner tubular member. However, a semi-cylindrical form is preferred. The heaters should not extend around an arc of substantially more than 180 degrees because they could not then be applied to the sides of the hot runner tubular members but instead would have to be slid over the ends of the hot runner tubular members, thus necessitating disassembly of the hot runner tubular members for heater installation.

The heater core 142 can if desired be eliminated. In that case the heater wire 148 is simply wound in a jig and is then located in a mold of size very slightly smaller than the inside size of metal shell 154. The mold is then filled with high thermal conductivity ceramic cement 189 (Fig. 12A) which is allowed partially to dry. (The cement is typically a ceramic powder, e.g. fused magnesium oxide powder, mixed with a small amount of water.) While semi-dry, the assembly is next carefully removed from the mold (since it is relatively weak) and placed in the metal shell 154. The shell 154 is then compressed slightly to compress it on to the ceramic cement and to compress the cement. This results in an inexpensive and accurately made heater. The heater wire can be wound in any desired configuration.

Reference is next made to Fig. 13 which shows a simplified arrangement for a gate. In the Fig. 13 arrangement, the insert member of a gate insert member 190 which is slidably housed in the bore of a hot runner tubular member 192 and which has a tapered end of tip 194 which fits snugly into a tapered aperture 196 in a mold cavity plate 198. The insert member 190 has an axial bore 200 terminating in a gate aperture 202, to direct plastics into a mold cavity defined in part by the cavity plate 198.

The portion of the insert member 190 projecting from the hot runner tubular member 192 includes a circumferential collar 204. A circular disc spring 206 thrusts against the tip of the hot runner tubular member 192 and against the collar 204 to force the insert member 190 downwardly against the mold cavity plate 198 to hold it stationary in position.

The apparatus shown in Fig. 13 is assembled by inserting the insert member 190 through the central hole in the disc spring 206 to bring the disc spring up against the collar 204, and then inserting the insert member 190 into the hot runner tubular member 192 to compress the disc spring 206. The insert member 190 is retained in position by a set screw 208 which is threadably inserted into the wall of the hot runner tubular member 192 and has a tip which engages in a circumferential groove 210 in the insert member 190. The groove 210 is wider than the tip of the set screw, to allow slight motion of the hot runner tubular member 192 relative to the insert member 190.

With the arrangement shown, the disc spring 206 holds the insert member 190 in place and at the same time absorbs heat expansion of the hot runner tubular member 192. The set screw 208, in addition to retaining the insert member in place, also serves to locate the end of the heater 211 which encircles the hot runner tubular member 192.

An additional feature of the Fig. 13 arrangement is that if the gate aperture 202 is positioned slightly off the axis of the insert member 190 as indicated at 202′, insert member 190 can be rotated to bring the gate aperture 202 to an optimum position depending on the article being molded. This is most useful when the wall thickness of the article being molded is not uniform and it is desirable to have more plastics flow to one location than another.

If desired, the insert member 190 may be fitted with a torpedo 212, as shown in Figs. 14, 15. The torpedo 212 has an elongated cylindrical body which is slid into the insert member and fits snugly therein. The torpedo 212 is held in position by a pin 213 which is inserted through one of two

diametrically opposed holes 214 in the wall of the insert member 190 into a corresponding diammetrical hole 216 in the torpedo. The pin 213 is prevented from falling out by the walls of the hot runner tubular member 192 into which the insert member 190 is inserted.

When in position, the torpedo 212 has a pointed tip 218 which enters the gate opening 202 to restrict this opening to the desired size. If desired, the tip 218 can be slightly off the axis of the torpedo to create a non-symmetrical flow, and the insert member with the torpedo 212 can be rotated inside the hot runner to utilize the non-symmetrical properties of the flow to optimum extent. The opposite tip 220 of the torpedo is also pointed, to allow smooth flow of plastics around it.

The torpedo 212 contains one or more longitudinal channels 222 to allow plastics flow through the insert member. (Two channels 222 are shown in Fig. 15). The channels 222 are of calibrated size, depending on the type of plastics being injected. When the type of plastics injected is changed, the torpedo 212 can easily be replaced by another torpedo having appropriate size channels 222.

Although the heater used for the hot runners may be as shown in Figs. 11, 12 and 12A, it will be appreciated that any other appropriate heater, and typically a standard cartridge heater, may also be used. Generally, because the ends of the insert members 48, 48′, 48″, 190 projecting from the hot runner do not need to engage a nut (since the insert members are retained by the hot runner), the absence of such a nut means that the end of the heater can be brought close to the end of the hot runner, thus reducing the likelihood that plastics will set in the insert members. The arrangements shown for the passages through the insert members also allow the plastics to flow in relatively straight paths through the insert members, and this further reduces the tendency of the plastics to set in the insert members (in this connection it should be noted that although the plastics flow passage through the insert member in Figure 1 has the bend 38, the substantial part of the passage is nonetheless straight, so that this insert member enjoys the advantage of the reduced tendency to setting).

It will be apparent that in the structures described above with reference to and as illustrated in Figures 3 to 15 the insert member is slidable within the end of the hot runner member in which it is carried, so that the insert member does not interfere with axial expansion and contraction movement of the hot runner member relative to the cavity plate 2.

WHAT I CLAIM IS:—

1. For a plastics injection mold structure including a cavity plate and a mold cavity bounded at least in part by the cavity plate, a hot runner structure comprising: a hot runner member having a first end for receiving plastics to be injection molded and a tubular second end for discharging the plastics; means for mounting the hot runner member for axial expansion and contraction movement of the second end relative to the cavity plate; a substantially cylindrical insert member sealingly fitted in the second end of the hot runner member and having an end portion projecting from the second end of the hot runner member; and a passage in the insert member for conducting the plastics from the hot runner member and for discharging the plastics from the insert member, the projecting end portion of the insert member having an end which in use co-operates with an opening in said cavity plate for directing plastics through the cavity plate into the mold cavity, the insert member being slidable within the second end of the hot runner member so that the insert member does not interfere with said axial movement of the second end of the hot runner member relative to the cavity plate.

2. Structure according to claim 1 wherein the insert member is a gate insert member, said end of the projecting end portion being tapered for fitting stationarily and snugly in the opening in the mold cavity plate and said end having a gate aperture therein.

3. Structure according to claim 2 wherein the passage in the insert member is a straight axial passage through the insert member to the gate aperture, the gate aperture being located off the axis of the insert member.

4. Structure according to claim 2 wherein the passage in the insert member is a straight axial passage through the insert member to the gate aperture, and further including a torpedo slidably disposed in the passage, and a pin inserted through the walls of the insert member and through the torpedo to retain the torpedo in the stem member, the torpedo having a narrowed tip capable of co-operating with the gate aperture to control flow of plastics through the gate aperture, and the torpedo also having calibrated passages therein to control flow of plastics past the torpedo.

5. Structure according to claim 1 wherein the projecting end portion of the insert member includes an external circumferential collar therearound, the structure further including spring means arranged between the collar and the second end of the hot runner member and operable to urge the insert member towards the mold cavity plate.

6. Structure according to claim 5 and including a circumferential groove in the external wall of the portion of the insert

member disposed within the hot runner member, and a set screw projecting through the wall of the hot runner member into the groove, the groove being wider than the width of the end of the set screw to allow limited axial movement of the insert member relative to the hot runner member.

7. Structure according to claim 6 wherein the set screw projects above the wall of the hot runner member, the exterior surface of the hot runner member being arranged to receive a heater, the projecting end of said set screw being arranged to locate the end of said heater.

8. Structure according to claim 7 wherein said spring means is a circular disc spring.

9. Structure according to claim 1 wherein the insert member is axially movable between a first position in which said end of the projecting end portion of the insert member blocks passage of plastics through said opening in the cavity plate and a second position in which said end of the projecting end portion is withdrawn from said opening to permit passage of plastics therethrough.

10. Structure according to claim 9 wherein the portion of the insert members within the hot runner member has a circumferential radially outwardly extending collar having an end face which in use co-operates with said cavity plate to define at least a portion of a chamber for plastics, said opening being disposed in said chamber and said end face closing the end of said chamber remote from the opening, and the diameter of the collar being such that the area on which in operation plastics presses to urge the insert member towards its said open position is greater than the area on which the plastics presses to urge the insert member towards its said closed position, wherein spring means are operable to urge the insert member towards its said closed position with a preselected force, said force being such that the insert member will move against the pressure of the spring means to its said open position when the pressure of the plastics increases beyond a predetermined level.

11. Structure according to claim 10 wherein the insert member includes a circumferential groove in its external surface, the groove being located in the end portion of the insert member within the hot runner member, and wherein the hot runner member has a pair of diametrically opposed slots in its wall over the groove, the groove being wider than the slots, and a pair of diametrically opposed springs disposed within the slots and pressing against a wall of the groove to urge the insert member towards its said closed position, the springs having outturned ends fitted between the groove and the interior surface of the second end of the hot runner member to retain the springs in position.

12. Structure according to claim 10 wherein the second end of the hot runner member has an end surface for defining a portion of said chamber, said second end including a seal at its said end surface for sealing against the cavity plate.

13. Structure according to claim 12 wherein said passage in the insert member includes an axial bore extending from that end of the insert member located within the hot runner member, and a plurality of smaller passages extending from the axial bore through the collar, the smaller passages being spaced around the collar.

14. Structure according to claim 13 having three said passages spaced at 120 degree intervals around the collar.

15. Structure according to claim 9 wherein the wall of the hot runner member adjacent its second end includes a pair of holes therein substantially sealed against escape of plastics by the sealing fit of the insert member in the second end of the hot runner member, said structure further including a pair of pins connected to the insert member and protruding through respective ones of the holes in the hot runner member, a hollow cylindrical piston encircling the second end of the hot runner member and connected to the pins, a cylinder encircling and guiding the piston, a collar on the piston in slidable contact against the wall of the cylinder, and means for admitting pressurised fluid to the cylinder on respective sides of the collar and for removing fluid from the cylinder on the respective other side of the collar to displace the piston within the cylinder.

16. A structure according to claim 1 wherein the second end of the hot runner member carries a seal for sealing said second end in a bore in the mold structure, the seal comprising a thin flexible cylindrical sleeve joined to said second end, the sleeve having a first part overlying said second end and a second part projecting from said second end, at least a substantial part of the second part being of a diameter which is equal to or slightly larger than the diameter of the bore in which in use said second end is received, and at least a substantial part of said first part being of a diameter which is equal to or slightly smaller than that of said bore, thereby to create a slidable seal between said second end and said bore.

17. Structure according to claim 16 wherein all of said first part and a portion of said second part of the sleeve adjacent said first part is of a diameter smaller than that of said bore.

18. Structure according to claim 16 or claim 17 wherein the diameter of said second part is in the range between the same diameter as that of said bore and .002 inches larger than that of said bore.

19. A structure according to claim 16,

claim 17 or claim 18 wherein the sleeve is of hardened steel and is fastened to the hot runner member by silver solder.

20. A hot runner structure substantially as hereinbefore described with reference to Figures 3 and 4, or Figures 5 to 8, or Figure 13, or Figures 14 and 15 of the accompanying drawings.

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1348276 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a. reduced scale*

Sheet 1

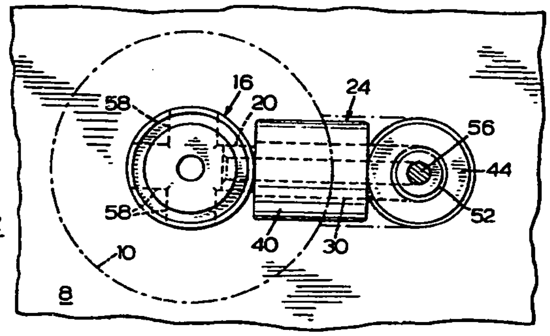


FIG. 2

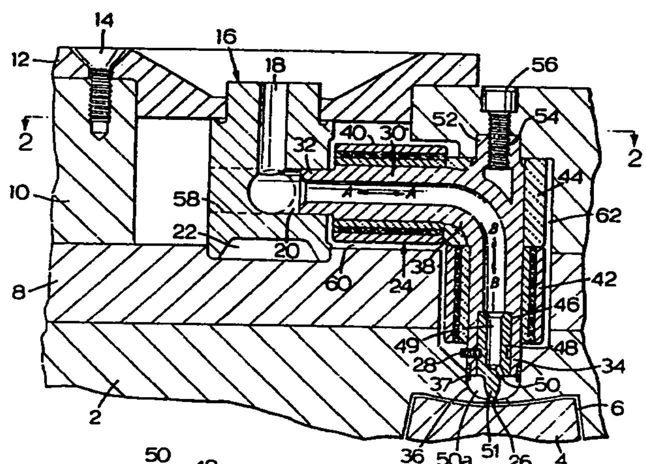


FIG.1

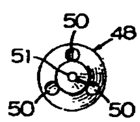


FIG. 1A

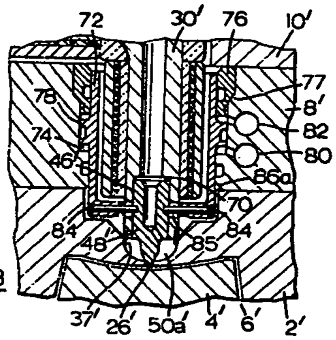


FIG. 3

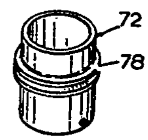


FIG. 4

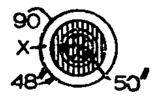


FIG.6

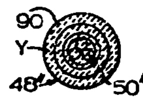


FIG. 7

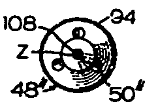


FIG. 8

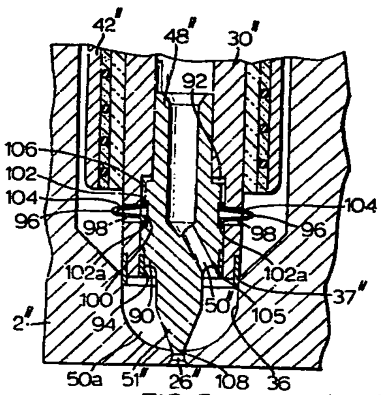


FIG 5

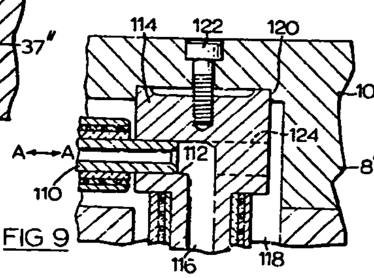


FIG 9

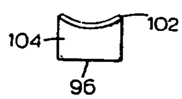


FIG 5A

1348276 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

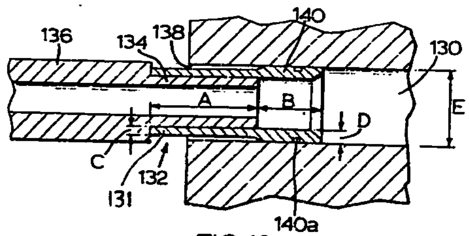


FIG. 10

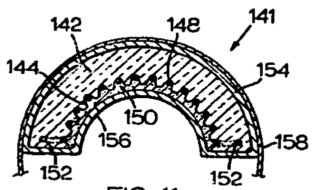


FIG. 11

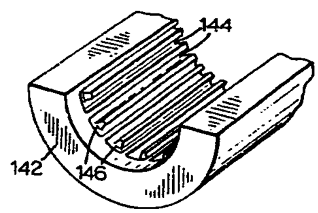
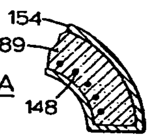


FIG. 12

FIG. 12A



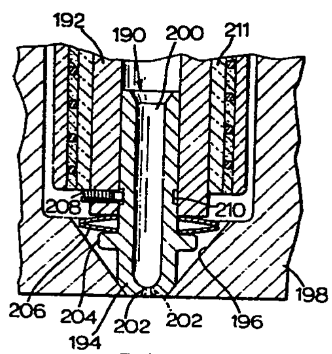


FIG. 13

FIG. 14

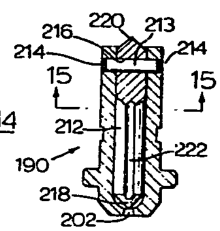


FIG. 15